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DEPARTMENT OF TRANSPORT

METHODOLOGY FOR THE DETERMINATION OF THE UNIT COST OF ROAD TRAFFIC COLLISIONS IN SOUTH AFRICA AS AN INPUT INTO ECONOMIC EVALUATION

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SINOPSIS

Padverkeersbotsings veroorsaak beide menslike en ekonomiese verliese. Owerhede en ander rolspelers benodig betroubare inligting oor die impak van botsings op die ekonomie. Botsingskostes word ook in die ekonomiese ontleding van projekvoorstelle gebruik en dit is belangrik dat inligting soos op datum hiervoor beskikbaar is. Die mees onlangse Suid-Afrikaanse studie om dié kostes te beraam is gedurende 1992 voltooi met 1991 data. Strukturele veranderinge in die ekonomie sedert daardie tydperk het die resultate van die 1992 studie onbetroubaar gemaak.

Die verslag neem die metodologië wat in Suid-Afrikaanse studies tussen 1962 en 1992 vir die beraming van botsingskostes gebruik is in oënskou, en ondersoek die bruikbaarheid van metodologië wat in onlangse internasionale studies gebruik is.

Die studie maak aanbevelings vir die opdatering van die Suid-Afrikaanse beramings, met Statistiek Suid-Afrika, die Nasionale Verkeersinligtingstelsel, kort-termyn versekeraars, die Padongelukfonds en pad operateurs as inligtingsbronne.

SYNOPSIS

Road traffic collisions result in both human loss and cost to the economy. Government and other role players addressing this problem require reliable information on the cost of collisions to the economy. Collision costs are also used in the economic evaluation of project proposals and it is essential that up-to-date information be available. The last South African study undertaken to estimate these costs was in 1992 using 1991 data. The occurrence of structural economic changes since that time have rendered the results of that study unreliable.

This report reviews the methodology for the estimation of the costs of collisions, including the methodologies used for earlier South African studies between 1962 and 1992, and the state-of-the-art of collision cost estimation internationally.

The study makes proposals for updating South African estimates, using information sources which include Statistics South Africa, the National Traffic Information System, short-term insurance companies, the Road Accident Fund and road operators.

TREFWOORDE: **KEYWORDS:**	padverkeer, padveiligheid, ongelukskostes, botsingskostes road traffic, road safety, accident cost, collision cost

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DISCLAIMER

The views and opinions expressed in this report are those of the authors and do not necessarily represent the policy of the Department of Transport.

The Department of Transport does not accept liability for the consequences of application of the findings expressed in this report.

REVIEW

This report has been reviewed internally by CSIR, (technical editing by Dr P N W Freeman and language editing by Mr C MacCarron) but has not yet been reviewed by the Department of Transport.

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1. BACKGROUND, PROBLEM STATEMENT AND DELIVERABLES

This document is a report on Phase 1 of an investigation for the National Department of Transport (NDoT):

"Revision of the Unit Cost of Road Traffic Collisions in South Africa as an Input into Economic Evaluation"

1.1 Background

Road traffic collisions have an enormous impact on South African society in terms of human loss, pain and suffering, and cost to the economy. It is evident that this situation cannot be left unattended and that all role players, including government, should actively become and/or remain involved in addressing this problem. For this, reliable information on the cost of road traffic collisions to the South African economy is needed. As collision costs are also an integral part of the economic evaluation of projects, it is essential that up-to-date information be used.

1.2 Problem statement

The previous study of this nature was done in 1992, using 1991 data. The likely occurrence of structural economic changes may have rendered the results of this study unreliable. The National Department of Transport would like to have these estimates updated regularly.

The method currently used in the program CB-ROADS does not take the income group of victims into consideration in the calculation of collision costs. The implications of this should be investigated. It is also necessary to investigate the nature of current "international best practice" for calculating collision cost and the implications of this for South Africa .

1.3 Methodology

The economic cost of road collisions results from the loss of output as a result of deaths and injuries, as well as the "physical" cost of collisions resulting from property damage, and from medical and legal costs. To determine this, data from various sources will be analysed. These sources include Statistics South Africa (SSA), short-term insurance companies and the Road Accident Fund (RAF).

1.4 Deliverables

The deliverables of the project will be updated values for the cost of road traffic collisions by severity (namely fatal, serious, slight and damage-only). The possibility of determining collision costs per type of collision (e.g. rear-end, side-swipe) from available data will also be investigated, as well as the implications of using current international best practice for calculating collision costs.

2. PRINCIPLES

2.1 Uses of collision cost data

Collision[1] cost information is used by the public sector at both macro and micro levels for a number of purposes in decision making, promotion, and lobbying:

For **policy formulation** - placing the overall road safety problem in perspective

For specific road **infrastructure decision making**, e.g. road investment (provision or rehabilitation), accident spot improvements

For road **operations decision making**, e.g. enforcement prioritisation, evaluation and selection of road safety countermeasures

For road **system management** - e.g. road pricing and cost recovery from users, allocation of financial and human resources

For **setting of standards**, e.g. road design standards, roadside furniture standards, vehicle safety standards

For **setting of road traffic regulations**, e.g. speed limits, vehicle weight and dimension limits

For **monitoring and regulation** of agencies.

In many cases the collision cost data are used as inputs to economic analyses, such as cost-benefit analyses.

Collision cost information is also important to the private sector and to individual road users, for example

1 In this report no fine distinction is made between the terms "accident" and "collision". The latter was preferred and adopted by the Department of Transport in the 1980s and is accordingly the preferred term in this report. In reviews of early or foreign reports using the term "accidents", that term is used to avoid confusion with the source documents. In recent US and Canadian documents the term "crash" is used. These and other terms and abbreviations are defined in Annexure A.

for purposes of insurance and compensation. This is however a matter for insurers and courts and is not the subject of this study.

2.2 Components of collision costs

The components or categories of collision costs include variable costs related to the occurrence of individual collisions and fixed costs related to systems created to prevent collisions and to minimise their consequences. Typical components considered in costing studies are listed in Table 1.

Table 1. The components of collision costs

Variable collision costs

- ❑ Human costs, both tangible (such as the value of lost economic output though death, work time lost through injury, vocational rehabilitation, the loss of unpaid services such as lost household production), and intangible (the value of human life, pain, grief and suffering, lost quality of life)
- ❑ Property costs - damage to vehicles, their loads, and fixed property
- ❑ Medical costs - ambulance, hospital, doctors and nurses
- ❑ Emergency services
- ❑ Legal costs - legal representation, court fees
- ❑ Administrative costs - insurance overheads
- ❑ Travel delays

Fixed costs related to collisions

- ❑ Safety promotion
- ❑ Collision preventative systems such as policing
- ❑ Collision response systems such as emergency medical services

Most of the costs and other consequences of collisions impact on the economy through the consumption of scarce resources. Some, particularly the intangibles, are felt or borne only by the individuals involved and the by persons close to them. From a macro-economic point of view, the identity of the bearer is unimportant, and all costs should be considered.

For public-sector use of collision costs in cost-benefit analyses it is customary to use resource costs and

not actual financial values as experienced by the user or victim. Road accident cost assessment is concerned with the economic costs of accidents - the real opportunity cost of all current and future resources which are expended or foregone because of road accidents. In practice the price charged for a resource might not reflect its cost - because the price charged might be a nominal one, be subsidised, or contain an excessive profit to permit cross-subsidy of another product or service. In most of the accident cost studies undertaken it is assumed that the prices reported are equal to the resource costs. This assumption may not be correct.

The valuation of human life

Valuing human life, pain, grief, and suffering is a controversial subject, and there are strong moral arguments against assigning a value to a human life. In reality, however, governments and individuals do not incur limitless expenditure to save or extend a human life. Implicit, if not explicit, valuations are placed on human life in many sectors.

For cost-benefit analyses, the economic costs of collisions to the economy are required. These include all of the components in Table 1 other than the intangible human costs. The latter, which are values rather than costs, should be included when an assessment is made of the total impact of collisions to the society and the economy.

For cost-benefit analyses, it is usual to include only the value of lost output or earnings, which are economic costs and are quantifiable, and constitute the economic component of the value of human life. It should be recognised that this underestimates the total impact of fatal accidents. Cillie and Freeman (1977) express this as "Ideally, the aggregate of accident costs would precisely measure, in monetary terms, the total reduction in societal welfare which is ascribable to the occurrence of accidents. Material losses can be translated into economic terms without very grave difficulty but it is conceptually awkward to assign monetary values to subjective impacts such as pain, grief etc. An approach often adopted in practice is to develop estimates for those costs which can reasonably be seen to represent the quantifiable or measurable part of society's loss through accidents, and to treat these costs as *minima*. Rather than to try to impute some hypothetical value to non-measurable losses, the rationale for viewing measurable costs as *minima* provides for the appraisal of subjective losses by the decision-maker on whatever basis he may deem appropriate".

Some approaches to analysis avoid this problem by not assigning costs or values to those consequences of collisions which are not readily expressed in economic terms. One of these is cost-effectiveness analysis, which uses as criterion the cost of measures (such as road improvements) per life saved, and is well suited to road safety management. Others are framework assessment, utility

analysis, and multi-criterion decision making which assess alternatives quantitatively without necessarily assigning monetary values to intangibles.

Some studies do, however, attempt to assess the intangibles by making a monetary allowance based on insurance compensation and court awards. This will be described later.

A Caution to the Reader - Injury vs Collision Costs

Quoted costs per one of the usual three severities of injury (fatal, serious, slight) would normally relate only to the human cost category in Table 1.

Quoted costs per one of the usual four severities of collision (fatal, major, minor, damage-only) would include all the cost components in Table 1.

Moreover, collisions might involve no, one, or more than one injuries or fatalities.

It is important to make and note this distinction between costs of injuries/fatalities and costs of collisions when interpreting or using quoted cost figures.

2.3 Output requirements

The cost breakdown required differs, depending on the intended use of the information. The required breakdown listed in Table 2 refers to the main uses that were listed in section 2.1. Except in the categories requiring total costs, the requirement is for unit costs per collision or injury.

Table 2: Collision cost breakdown required for various uses

INTENDED USE OF INFORMATION	BREAKDOWN DESIRED
Policy formulation, pricing and strategic management	Total cost, eg all collisions in a certain jurisdiction per year By location, eg urban vs rural developed vs developing areas By vehicle type involved, eg motor car motor cycle pedestrian, cyclist or animal-drawn minibus, bus heavy goods vehicle By road user injured, eg driver passenger pedestrian By income group of road user
Major infrastructure investment decisions using cost-benefit analyses	By severity of collision, eg fatal major or serious minor or slight damage only By road classification, eg gravel, surfaced two-lane, divided carriageway with limited access By location, eg urban vs rural developed vs developing areas
Minor infrastructure decisions, such as accident spot improvement	By type of collision, e.g. from collision diagrams: head-on, rear-end, side-swipe; low-speed, ... By type of vehicle where a specific type of vehicle is the cause for concern - e.g. heavy vehicles involved in runaway collisions
Accident countermeasure selection and justification	Some or all of the above
Collision awareness publicity and campaigns	Total cost By road user injured, eg driver passenger pedestrian

Other bases for differentiation, or more categories of differentiation are possible as well, and could lead to more accurate costing, but would result in high additional costs for data collection and analysis.

Andreassen (Traffic Engineering and Control, 1992) cautioned against the application of general accident costs in the benefit-cost evaluation of measures relating to specific types of accidents, which could lead to erroneous conclusions. This is discussed in section 3.3.3.

Certain bases of differentiation are ethically undesirable. For example, differentiation by age, race or gender could be construed as being contrary to the principles of the RSA Constitution. Similarly, differentiation by income group could be construed as leading to discrimination against the poor.

These categories are not independent: some are interrelated or overlap. Selection of one category may mean implicit selection of another category as well. This may be used to reduce the amount of effort required in analysis and presentation of the data.

In addition to estimating the total cost of collisions, a suggested breakdown for the purpose of this study, which is a compromise between needs and feasibility, and which covers most of the categories listed in Table 1 either directly or implicitly, is shown in Table 3.

Individual studies should be tailored to specific needs and to the data and funds available.

Table 3: Collision cost breakdown suggested
BREAKDOWN
By location urban vs rural different provinces
By vehicle type involved motor car motorcycle pedestrian, cyclist or animal-drawn minibus, bus heavy goods vehicle
By road user injured driver passenger pedestrian
By severity of collision fatal major or serious minor or slight damage only

3. LITERATURE ON COLLISION COSTS

3.1 Pioneering studies

The pioneering work on the estimation of accident costs was carried out in the UK and USA in the 1950s and 1960s.

Reynolds (1956) at the Road Research Laboratory in the UK set the format that was followed in subsequent studies: "The occurrence of road accidents inflicts a burden on the community which may be considered in two parts:

(i) The pain, fear and suffering imposed by the occurrence, or the risk of occurrence, of road accidents. These are considered of great importance in a society that values human life and human welfare.

(ii) The more concrete and ascertainable burdens in the form of net loss of output of goods and services due to death and injury and the expenditure or resources necessary to make good the effects of accidents, e.g. medical expenses, vehicle repairs and costs of administration.

For a variety of reasons it is beyond the competence of the economist to assign objective values to the losses suffered under (i) and this paper is therefore confined to the estimation of the burdens listed under (ii).

The effects of road accidents which are within the competence of the economist to evaluate are as follows:

Damage to property, which consists mainly of damage to vehicles

Medical costs which are incurred for the treatment of casualties

Administrative costs, e.g. that part of the administrative costs of motor insurance which can be ascribed to the occurrence of accidents

The net reduction in output of goods and services due to loss of output from people killed or injured, allowance being made in the case of persons killed for the goods and services they

would otherwise have consumed

In addition there are other effects which, although theoretically capable of evaluation, cannot be measured because of lack of data. These appear to be small and their exclusion would probably have very little effect on the final calculations. They are as follows:

> Administrative costs incurred by the police, the government and lawyers because of the occurrence of accidents. These cannot be separated from the cost incurred during the performance of their other duties.
>
> The economic effects of a smaller population. With the existence of road accidents the population of Great Britain will be smaller and of a slightly different age/sex occupational structure.
>
> The effect of transfers of income within the community. With the occurrence of accidents, income is transferred from the rest of the community in compensation to those who suffer loss from the accidents, without any necessary change in the resources at the disposal of the community. It is impossible to estimate this change".

Reynolds then went on to do pioneering work in locating sources and in developing methods of analysing appropriate data.

Winfrey (1969) considered the many elements within the total costs of traffic accidents. "These elements may be classified by several schemes, depending on which scheme serves the purpose to greater advantage. There are direct and indirect costs, on-site and off-site costs, immediate and future costs, cash costs and non-cash costs, cost of goods and cost of personal services, costs to those involved in the accident and the costs to others, priceable costs and unpriceable costs, and tangible and intangible costs. No one classifying system will serve all purposes to equal advantage". Winfrey proposed nine groupings of traffic accident costs (Table 4) in an attempt to bring to light and into sharper focus the many and varied cost elements, regardless of their magnitude.

Table 4. Elements of costs and benefits associated with highway traffic accidents	
A	Goods and other property consumed
B	Transportation and communications
C	Personal services rendered
D	Time consumed by all persons affected
E	Unclassified, including insurance
F	Anguish, anxiety, misery, and suffering
G	Benefits received and normal expenses avoided
H	Governmental service and operations
I	Activities to reduce the number of accidents and their severity

Source: Winfrey (1969)

His detailed list of elements included many items that have been ignored in subsequent accident cost studies.

Winfrey expressed an early view on the still-controversial subject of how to treat death in accident cost analysis. "That the probable future income of persons who die as a result of traffic accidents or whose probable future incomes are materially reduced represent some sort of cost chargeable to accidents is generally accepted. In principle, a fatal accident or permanently disabling injury need be treated no differently from other accidents. The cost of fatal injury accidents and accidents that result in permanent disability may be viewed from three aspects:

i) the cost of property damage, medical attention, and other direct expense
ii) the worth of life to relatives and friends viewed from sentiment and love
iii) the economic loss because a producing person is removed from his role in society as a producer. Compensation for body disfigurement may be included with this third factor.

The commodity, service, and all cash costs associated with the fatal injury accident (i.e. i and iii) call for treatment no different than for other accidents. ... The worth of life to those persons who have a personal care (i.e. ii) is without a sound basis for estimating. ... The value of human life is not a cost in the sense that an expense is suffered. Economy studies of highway improvements should not include the value of life as a sentimental factor, but only as an economic factor. ... A net value of man as an

economic machine when developed as the present worth of his probable future net income (as a measure of his contribution to society), less the present worth of his probable future living and other expenses (as a measure of the cost incident to his contribution to society)[2], offers a reasonable economic base for comparing highway investment alternatives in which fatalities and permanent disabilities are a factor. This scheme has the advantage that it does not require placing a value on a life simply as an individual and the scheme is in harmony with the general approach of placing a value on travel time".

Winfrey then proceeds to describe a methodology for calculating the net economic worth of a person, which was used as a basis for many subsequent studies.

3.2 South African studies

The CSIR has been estimating the unit and total costs of road collisions in South Africa periodically since 1962:

1962 de Vos and Burton, 1965
1963 Burton and Eksteen, 1967
1972 Cillie, 1975
1975 Cillie and Freeman, 1977
1979 Goosen, 1980
1980 Goosen and Kolman, 1982
1984 Verburgh, Farquharson and Hamilton, 1985
1986 Glass and Hamilton, 1987
1988 Morden, 1989
1991 de Haan, 1992

During this period the methodology improved, based on both local and international research. The early estimates focussed on the economically quantifiable collision cost components, while the later estimates included attempts to quantify the intangible components as well. These studies are reviewed briefly below, as a basis for selecting the most appropriate methodology for the present study.

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[2] This is equivalent to the "net output" approach discussed later

3.2.1 The early studies

The early CSIR studies set the basis for future South African work, including the identification of the components of collision costs and methods of estimating them:

Damage to property
Medical costs
Loss of use of vehicle
Value of work time lost
Legal and court fees
Damage awards and settlements
Administrative costs

but found it difficult to assign monetary values to the humanitarian consequences of road accidents, those administrative system costs related to accidents incurred by police, government and lawyers, the economic effects of a smaller population, and the net reduction in output of goods and services as a result of the loss of life or permanent injuries (de Vos and Burton, 1965). They noted that economic studies were primarily concerned with the average costs of accident by type of accident and severity. They sought to classify accidents by four degrees of severity

fatal
major or serious injury
minor or slight injury, and
no injury or damage only

- a classification which has been maintained in all of the studies conducted since then. In addition, they identified a need to classify accidents into one of six types

two motor vehicle
motor cycle
pedal cycle
pedestrian
animal, and
single motor vehicle accidents.

This meant that there were 24 accident categories for which average costs were sought, but they were unable to do this because of a lack of data.

Burton and Eksteen (1967) gathered data on the costs of damage to vehicles (classified by vehicle type and extent of damage) from motor car comprehensive insurance records, from the South African Railways for lorries and light delivery vehicles, and from the Pretoria Municipality for buses. The costs of injury to persons (classified by race and sex of casualty and severity of injury) were obtained from third party insurance claims.

Their estimates excluded the cost of police time and court proceedings resulting from the occurrence of road accidents, the cost of damage to road furniture, the cost of damage to the cargo in the vehicles involved, the cost of management of insurance companies undertaking motor insurance business and the cost of loss of human life or output.

3.2.2 The "gross output" studies

In 1975 Cillie undertook a major revision of the earlier accident costing approach, incorporating new techniques developed overseas.

Cillie made estimates for the variable costs of road accidents (loss of output, property damage costs, medical costs, administrative costs and legal costs), examined fixed costs only briefly and excluded intangible or subjective costs (pain, suffering, grief, anxiety, stress, fear, inconvenience, the "value" of human life).

Lost output was included in this estimate for the first time. This included permanent loss through death or total disability, and temporary loss of output through injury. He assessed the cost of permanent loss as the loss of gross future output, as opposed to loss of net future output in which future consumption would be subtracted from the gross output. The gross output was preferred as the use of the net output concept would impute a negative value to the lives of many of the persons who are killed in road accidents - i.e. those whose future consumption would exceed their future economic production, such as retired, disabled, and chronically unemployed persons. The loss of output through injury was assessed as the loss of income for the period until work was resumed. Cillie included another new category, the loss of unpaid services which are not reflected in the national income accounting system (such as the services rendered by housewives and voluntary or welfare workers) and expressed these as an opportunity cost equal to the average earnings of equivalent persons in formal employment.

Medical and funeral costs relating to fatalities should be assessed as the difference between the costs of hospitalisation, medical treatment, and funeral resulting from a road accident, and the present value of the future costs of this type relating to natural death at a future time. The assumption was made that the discounted values for future death owing to natural causes was small, and the full values of medical

and funeral costs resulting from an accident were included.

Two different types of costs were considered under policing costs. It was considered that traffic policing of roads and traffic control are not directly related to accident occurrence and that these costs are incurred by the authorities to promote the smooth overall functioning of the road transportation system. The second type of costs are those incurred by the South African Police in the investigation of road accidents and the recording of accident data, were directly accident-related and are fully chargeable. Cillie therefore did not charge traffic policing and control costs as road accident costs, but included the accident investigation costs under administrative costs.

Cillie also included fixed or non-variable costs. Sums expended in the promotion of road safety by the National Road Safety Council and other authorities, and road safety research expenditure, would not have been incurred in the absence of road accidents, and were charged as one of the fixed costs of road accidents. Other non-variable costs, such as the costs incurred by motor vehicle manufacturers in manufacturing vehicles to higher safety standards, and the costs of road authorities in building roads to higher safety standards, were excluded in Cillie's study. The non-variable costs of motor insurance administration were included.

Cillie and Freeman (1977) refined this work, again concentrating only on the measurable costs and only considering the variable costs in any detail. They described the nature of accident costs: "All losses which are occasioned directly or indirectly by the occurrence of road accidents may be termed road accident costs". Certain losses involve a consumption of material resources while others relate to totally subjective impacts. Accident costs are borne by individuals (road users and non-users) as well as by the community at large but, from a macro-economic or societal point of view, the identity of the ultimate bearer of these costs is not relevant. Sometimes accident costs are direct cash - i.e. "out-of-pocket" costs; in other instances they are indirect, non-monetary economic costs, while in still others they are simply intangible "human" costs".

Cillie and Freeman (1977) noted that "A large number of cost concepts can be identified in a study of road accident costs. For example, a distinction can be made between, amongst others, measurable and non-measurable costs, variable and fixed costs, direct and indirect costs, market and non-market costs, user and non-user costs etc." They selected the classification of costs shown in Table 5 as being the most useful.

Table 5. Categories of Road Accident Costs

	MEASURABLE COSTS	NON-MEASURABLE COSTS
VARIABLE COSTS	1 Loss of output 2 Property damage costs 3 Medical costs 4 Administrative costs 5 Legal costs 6 Loss of time 7 Miscellaneous incidental costs e.g. telephone calls, telegrams, flowers, travelling expenses, towing costs, hiring of domestic help etc	1 The "value of human life" 2 Loss of "life's amenities" 3 Physical and mental suffering i.e. pain, shock, anguish, horror, grief, fear etc 4 Inconvenience and disruption 5 Other intangible disbenefits e.g. anxiety, tension, frustration, loneliness, fatigue, nervousness etc
FIXED COSTS	1 Non-variable administrative costs 2 Road safety research and promotion 3 Processing and publishing of road accident data 4 Road improvements directly related to safety 5 Road safety policing and enforcement 6 Other fixed costs	

Source: Cillie and Freeman, 1977

Cillie and Freeman's (1977) approach was basically the same as that of Cillie (1975).

Goosen (1980) and Goosen and Kolman (1982) updated the estimates, also using the same approach as the 1975 study. They drew a larger sample of insurance data, thereby improving the confidence level of the estimates, and improved the estimates of the relationship between accident severity and property damage. New data sources were established, thereby reducing the number of assumptions that had to be made. However, they raised doubts about the quality of the road accident data, particularly as regards the completion of accident report forms by the police. They also expressed concern at the fact

that the data collected from insurance companies was not representative of accidents involving vehicle owners from lower income groups, who generally did not carry comprehensive insurance on their vehicles.

Verburgh et al (1985) updated the South African estimates, again using the "gross output" approach. They, however, began to introduce new approaches to improve the accuracy. "One approach that has received much attention during the past few years is the "willingness to pay" for the reduction of accident risk. It suggests that the traditional "gross output" approach to evaluating traffic accidents seriously underestimates the overall cost of traffic accidents to the community. The gross output approach followed in this study is a first and essential approach, however, particularly as far as South African conditions are concerned, and ideally it should be followed by a second study applying the 'willingness-to-pay' approach". Their conclusion led to the studies described in the following section.

Glass and Hamilton (1987) reapplied the methodology used by Verburgh et al (1985) for their update, as did Morden (1989). Morden made an attempt, for the first time, to estimate the costs of pain and suffering to those injured in collisions based on awards by courts, and found that these were higher than the average compensation paid from the MVA fund for pain, suffering and loss of amenities of life.

De Haan (1992) reviewed the work of Hills, Jones-Lee, Floor and Morden and concluded that in the South African context, the reservations about application of the willingness to pay approach were valid. She therefore remained with the gross output approach (with an additional allowance for pain, grief and suffering) in her study for estimating road collision costs for South Africa. This, the most recent of the comprehensive CSIR studies, derived data from various sources, with the bulk of the effort being devoted to two surveys, the sample sizes of which were determined statistically to provide reliable estimates of the cost components:

A survey of 2464 claims at six short-term motor vehicle insurers, yielding data mainly relating to vehicle and property damage

A survey of 3656 claims at four insurers acting as agents for the Multilateral Motor Vehicle Accidents Fund (MVA Fund) yielding data regarding personal injuries.

The loss of output determined in the above studies was based on the earnings of the victims at the time of the collision, projected for the remainder of what would have been their productive lives and discounted to present values. A different and simpler approach was adopted in the 1994 revision of CB-Roads (SARB 1994), which based the loss of output on the GDP per capita published by the Central Statistical Service.

In 1994 Schutte examined the validity of the figures for income per capita and income per worker which were used as a basis for valuing lost output in the CEAS manual for cost-benefit analysis in South Africa. He concluded that these figures were not correct, and would lead to erroneous cost-benefit conclusions, and recommended that they be revised. This also led to questioning the validity of costing loss of output on the basis of the GDP per capita, which effectively averages "output" across the entire population, whether economically employed or not. (Schutte 1994).

In 1997 Pretorius undertook a more focussed study of the costs of a specific category of collisions which had become the subject of increasing concern, namely collisions involving heavy vehicles (Pretorius et al, 1997). The methodology was basically that of de Haan, but with a greater emphasis on on-site costs, on damage to cargo and to property outside the vehicle, and on the time costs associated with the delayed arrival of goods and the cost of buying delayed goods in advance. This is reflected in the cost categories which she investigated (Table 6). She made use of data from collision and incident management databases for Durban and portion of the N3.

Table 6. Cost categories - heavy vehicle collisions
Direct costs
❒ On-site costs (emergency medical service, towing services, clean-up team, fire service, Road Traffic Inspectorate, SAPS)
❒ Vehicle and property damage costs (cargo loss, vehicle repair or replacement, property outside the vehicle)
❒ Human costs (pain and suffering, hospital, medical, funeral)
❒ Lost output (loss of earnings)
❒ Administrative costs (Insurance administration, Police administration, legal costs)
Indirect costs
❒ Time costs
❒ Cost of buying delayed goods in advance (excess inventory)

Source: Pretorius, 1997

3.2.3 The "willingness-to-pay" studies

Each of the last four studies - Verburgh et al (1985), Glass and Hamilton (1987), Morden (1989) and de Haan (1992) - expressed concern about the shortcomings of the methodologies used in previous studies and expressed interest in the potential of a "willingness to pay" approach. However, they each utilised

the "gross output" approach for their estimates, pending exploration of the "willingness-to-pay" approach and overcoming the problems with its application.

Hills et al (1983) from the University of Newcastle-upon-Tyne had described six approaches that had been proposed for the costing and valuation of road traffic accidents, concentrating upon the kind of accident involving one fatality:

> "**The gross output (or human capital) approach**, in which the cost of a road collision involving one fatality is treated as the sum of the resource costs (such as vehicle damage, medical and police costs) and the discounted present value of the victim's future (lost) output. .. In some variants of this approach, a significant sum is added to the output loss and resource costs to reflect the "pain, grief and suffering" of the accident victim and those who care for him or her.
>
> **The net output approach**, which differs from the previous only to the extent that the present value of the victim's future consumption is subtracted from the gross output figure. ...
>
> **The life-insurance approach**, in which the cost of a road accident or the value of accident prevention is directly related to the sums for which 'typical' individuals are willing to ensure their own lives.
>
> **The court-award approach**, in which the sums awarded by the courts to the surviving dependents of those killed as a result of either crime or negligence are treated as indicative of the cost that society associates with the accident or the value that it would have placed on its prevention.
>
> **The implicit public sector valuation approach**, in which an attempt is made to determine the costs and values that are implicitly placed on road collision prevention in safety legislation or in public sector decisions taken either in favour of or against investment programmes that affect safety.
>
> **The willingness-to-pay approach**, which is founded on the fundamental premise that allocative decision-making in the public sector should reflect the interests and wishes of those individual citizens who will be affected by the decisions. Accordingly, the value of safety improvement is defined in terms of the amount people are willing to pay for it; the cost of a deterioration in safety being defined analogously in terms of the amount people would require in compensation for increased risk".

Hills et al addressed the question of which of these methods is the most appropriate for highway investment appraisal in developing countries, and responded that this would depend on the use to which the cost data were to be put. They considered two alternative objectives of highway investment appraisal, namely **national output objectives** such as the maximisation of GNP or GNP per capita, and **social welfare objectives** such as the maximisation of the well-being of the individuals who comprise society, including the pursuit of "quality of life" objectives which, in turn, might include the minimisation of fatalities resulting from road accidents. They suggest that "in the majority of cases, developing countries' road investment policies would probably be pursuant to one of two classes of overall objectives: either national output objectives or the rather wider class of social welfare objectives. For those developing countries whose economic and social policies are tied more closely to output objectives (i.e. maximising GNP), the definition and estimation of accident costs and values is fairly straightforward and will involve variants of the standard gross output measures. If, however, a developing country wishes to take the rather wider "warm-blooded" view of road safety policy entailed in the social welfare objective, then the willingness-to-pay definition of accident costs and values would be more appropriate" (i.e. maximising social welfare) - Hills et al, 1983.

South African policy, as expressed in both the RDP and GEAR policies, includes both economic growth and social welfare, and therefore Hills' conclusion implies that the willingness-to-pay approach should be considered.

One drawback of the willingness-to-pay method is that, particularly in South Africa which is part developing and part developed, the data required for estimating individual "willingness to pay" amounts are either not available or are very difficult to obtain. During a visit to South Africa in 1984 Jones-Lee considered a "gross output" study to be essential for obtaining the basic cost picture of South African road accidents, but that the application of the "willingness-to-pay" methods would provide important additional information, particularly in respect of the value of human lives (Verburgh et al, 1985).

Jones-Lee (1984) considered two main methods for estimating the marginal rates of substitution or willingness to pay, namely the use of revealed or stated preferences:

> "The **revealed preference** approach obtains information on the basis of observed choices in situations in which people actually make such trade-offs (in the labour market). Situations involving pure wealth/risk trade-offs are rare, and care is needed to disentangle the effects of other factors should this approach be used.
>
> "The **questionnaire** or **stated preference** approach entails asking a sample of individuals, more or less directly, how much they would each be willing to pay to effect various reductions

in their own or other people's risk. The questionnaire approach has the great advantage of allowing the researcher to "tailor" the survey instrument and sample to elicit precisely the kind of information required. Its chief drawback is that it is based on the responses of individuals to hypothetical rather than actual situations".

Of these the questionnaire approach is the most direct, but there is some doubt about the reliability and credibility of responses, such as whether responses to hypothetical valuation questions would translate into equivalent action in reality, and whether respondents would be able to understand and make fine evaluative discriminations relating to risks with low probabilities. In Jones-Lee's UK survey, consistency and perception tests had been built into the questionnaires to enable the more obvious cases of misrepresentation or random guessing in valuation responses and inability to handle probability concepts to be detected.

Resulting from these indications of the potential of the "willingness-to-pay approach", Floor (1989) and Morden (1991) attempted to apply it in South Africa.

Floor and Greenwood (1989) carried out a survey to determine the willingness of road users to pay for geometric improvements which contribute to road safety. "The assumption is that those individuals affected by improvements in safety are willing to pay accordingly. In economic terms, the willingness to pay is the rate at which an individual is willing to trade off income/wealth for safety. To this value, it is necessary to add the real resource effects of variations in accident rates, if individuals fail to take them into account.... Interviews using questionnaires were undertaken in order to estimate the rates at which individuals are willing to trade off wealth/income for reductions in accident risk. The reason for using this approach is that it could be designed to elicit precisely the kind of information required. The drawback, however, is that the response of the subjects is necessarily hypothetical". Their questionnaire contained questions regarding the respondent's opinion of the relation between road features (categories from narrow two lane roads up to divided carriageway freeways) and the reduction in road accidents, the respondent's road preference, and willingness to pay for the features of a specific road type. Some respondents had difficulty in answering the valuation questions and their answers proved to be meaningless. The hypothetical nature of some of the questions also presented problems. Some respondents became sidetracked by issues such as the controversy which accompanied the introduction of toll roads in South Africa - with responses such as "taxes were already sufficiently high to cover road building costs" or "roads are public goods paid from taxes - why, after all this, should users be charged?" They concluded that "South African motorists tend to believe that the roads are unsafe and are willing to afford roads designed to reduce the risk of accidents, but are unwilling to contribute towards the costs in the form of tolls or higher taxes because of (i), public resentment towards the tolling of existing roads and (ii), the view that the taxation of motorists is already excessive and that the tax income which should

be allocated to road building is being misused for other purposes". In all, the study was unsuccessful in determining values for willingness to pay, but it did contribute by revealing some methodological pitfalls.

Morden (1991) carried out a survey to determine the willingness of individuals to contribute to improved road safety, based on the work of Jones-Lee et al (1987) and using the questionnaire approach described above. The questionnaire designed by Jones-Lee was used as the basis for the questionnaire used in the study and consisted of factual, perception and valuation questions. Personal face-to-face interviews were conducted with a stratified sample of respondents in their home language, using prompt cards to simplify the probability concepts associated with death or injuries in traffic collisions. The survey was more successful than that of Floor, yet it too encountered problems of understanding of risk concepts, and an overwhelming percentage of respondents considered that the government was responsible for improved road safety and were not prepared to contribute. The study did however yield average rates people were prepared to pay for various safety improvements, and it was possible to derive a value for life from the responses. Some important questions of interpretation however remained.

Overseas the willingness-to-pay approach has been assessed, but has met with mixed acceptance. The UK Department of Transport initially rejected this approach to the evaluation of collision costs because of severe methodological and practical difficulties and because research based on this method produced a wide range of values (Sharp, 1988). More recently however the UK Department of Transport has adopted the willingness-to-pay measure for the value of life (Maddison et al 1996). This will be discussed in a later section.

3.2.4 Quantitative comparison of the earlier South African estimates

The CSIR's estimates of the unit and total costs of road collisions in South Africa carried out periodically since 1962 are summarised in Table 7. The latest estimates made by CSIR were for 1991. Since that time, when the National Department of Transport required estimates, these were made by escalating the previous rates to allow inflation and traffic growth to be taken into account. The latter estimates are less substantiated, but for completeness the latest such estimate is shown in Table 7.

Table 7. Earlier estimates of the costs of road traffic collisions in South Africa

Year	Number of collisions (1000s)	Unit cost of collision (all categories) (Rand)	Total cost of collisions, (R millions)	Collision cost components included	Reference
1962	110	440	48	Injury, damage, admin	de Vos et al, 1965
1963	121	570	69	As previous	Burton et al, 1967
1972	268	1210	325	As previous, plus loss of output	Cillie, 1975
1975	321	1810	610	As previous	Cillie et al, 1977
1979	329	2590	853	As previous	Goosen, 1980
1980	397	3950	1260	As previous	Goosen et al, 1982
1984	419	5420	2480	As previous	Verburgh et al, 1984
1986	373	11100	4134	As previous	Glass et al, 1986
1988	418	11900	4991	As previous, plus pain & suffering	Morden, 1989
1991	433	15800	6862	As previous, but with pedestrians separated	de Haan, 1992
1993		18100		As previous, but with loss of output based on GDP/cap	CB-Roads
1996	521	23000	11990*	As de Haan, but escalated	Moving South Africa

* This estimate was not based on research, but on escalation of the previous estimate.

These data are depicted graphically in Figure 1 and the inflation adjusted estimates in Figure 2.

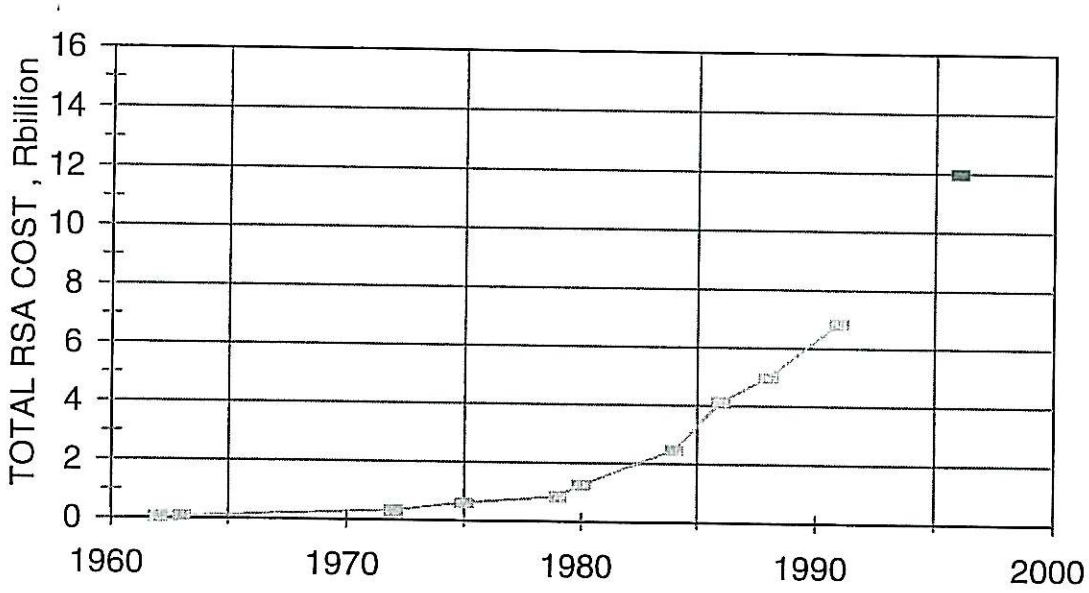

Figure 1. Earlier estimates of the total annual cost of road collisions in South Africa.

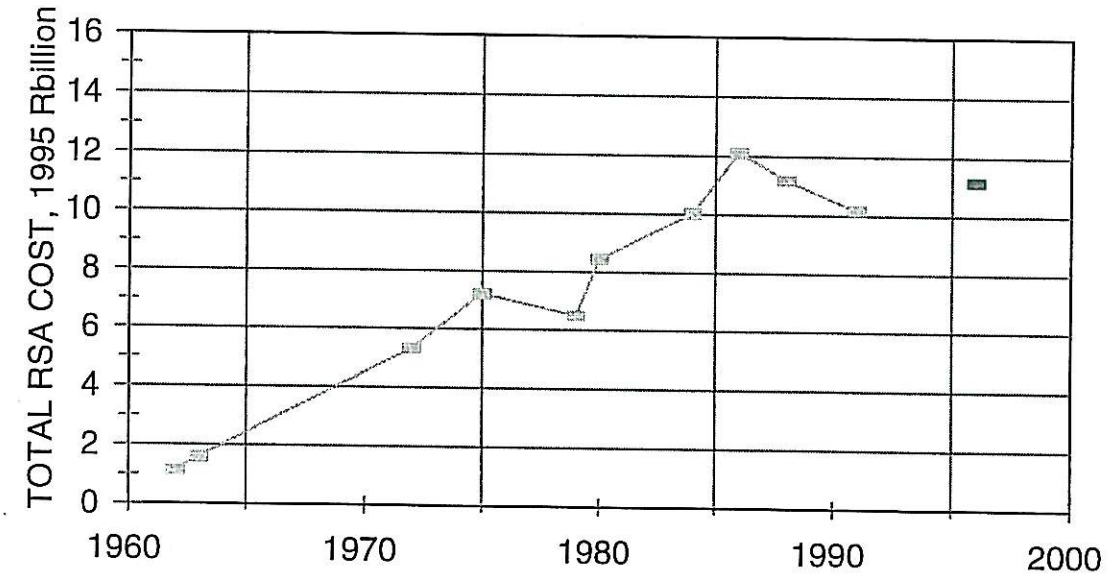

Figure 2. Earlier estimates of the total annual cost of road collisions in South Africa, adjusted for inflation (1995 Rands).

The research estimates of the total costs of road collisions in South Africa over this period of time are not directly comparable with one another. Reasons for the changes from year to year include:

Inflation
Growth of road traffic volumes
Changes in collision rates
Changes in South African political boundaries
Changes in the methodology used for estimating costs, as described previously

More comparable figures are the inflation-adjusted unit costs of collisions, as shown in Figure 3. This figure should exclude the differences resulting from inflation, the growth in traffic, and changes in collision rates, but even these are not directly comparable, because of the changes in methodology.

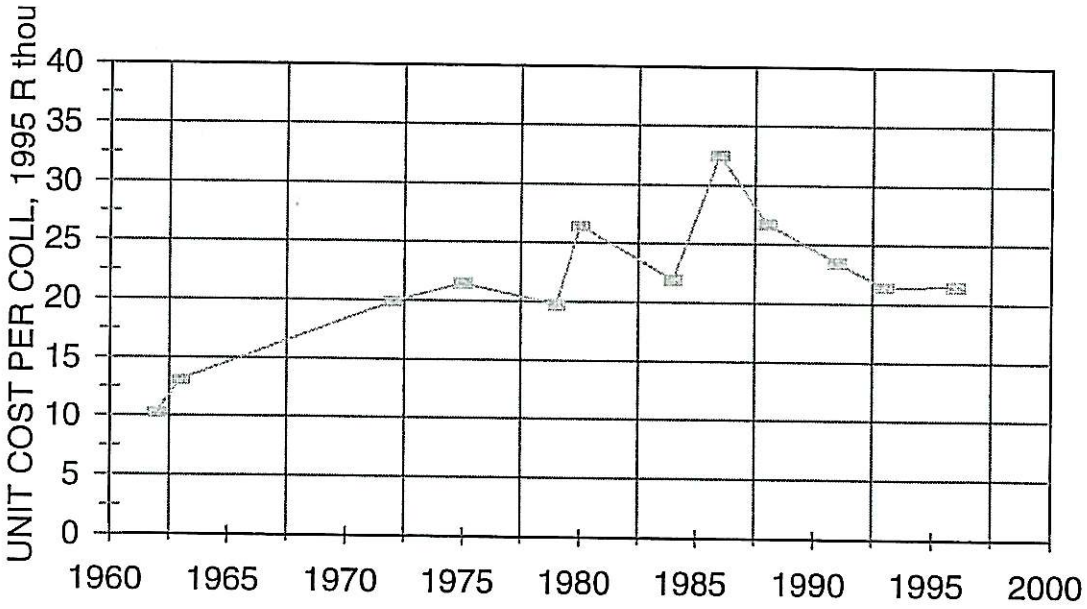

Figure 3. Earlier estimates of the unit costs of road collisions in South Africa, adjusted for inflation (1995 Rands).

The most significant changes in the components included in the estimates were the inclusion of loss of output from 1972, and the inclusion of pain and suffering from 1988. Progressive refinements in methodology over time would also have resulted in slight increases in the estimates, without however implying any substantial change in unit costs. Other year-to-year changes might not represent real

changes in unit costs, but may simply be the result of random differences resulting from inadequate sizes of the samples. After allowing for these, overall the unit costs in real terms have remained fairly constant.

One may speculate on factors which might have caused real changes in the unit rates over time, but the above data where many variables were changing simultaneously do not permit the causes to be identified.

Factor which might have caused <u>decreases</u> in unit costs of collisions	**Factors which might have caused <u>increases</u> in unit costs of collisions**
Effects of international low-speed collision protection legislation New vehicle design and materials, replace rather than repair	Increased sophistication of vehicles as a result of user demands Changing vehicle legislation, such as that allowing for increased truck sizes Modal shifts resulting in increased road freight and public passenger transport Increased unit value of goods transported by road Increased insurance claims per collision (but now capped)

3.3 Recent international literature

In this section some recent accident cost studies or methodologies reported overseas are described.

A Caution to the Reader - Willingness to Pay

Some of the international studies discussed in this section use the "gross or net output" approach, others "willingness-to-pay". There seems to be inconsistency internationally in the use of these terms and as to which of the cost components listed in Table 1 tare included in these.

The "gross or net output" refers to the tangible human cost (loss of output) only.

In some cases "willingness-to-pay" refers to the amount a person is willing to pay for the avoidance of the intangible human costs (e.g. value of life, pain and suffering) associated with a fatality or injury; in others it refers to the avoidance of an accident with both its intangible human and the other consequences borne by individuals. To this should be added the tangible human costs (e.g. loss of output) borne by the economy.

In both approaches, in order to determine the total cost of a fatal or other accident the property, medical, emergency, legal, and administrative costs should be added to the above figures.

"Willingness-to-pay" is only one cost component, and may not include all the costs listed in Table 1.

3.3.1 National Highway Traffic Safety Administration

The National Highway Traffic Safety Administration (NHTSA) of the US Department of Transportation reported the results of a study of the economic cost of motor vehicle crashes in the USA for 1994 (Blincoe, 1994).

"The costs documented in the report are the economic or 'human capital' cost components for motor vehicle injuries and crashes. The conceptual framework of human capital costs encompasses direct and indirect costs to individuals and to society as a whole from decreases in the general health status of those injured in crashes. Individuals are seen as producers and consumers of a stream of output throughout their lifetime. Injured individuals are considered part of total societal impact, hence the value of their decreased production and their decreased consumption is included in total cost. The resources consumed in response to any injury or crash that might otherwise be used for increasing the general state of well-being in society also are counted in total cost.

Direct costs include emergency treatment, initial medical costs, rehabilitation costs, long-term care and treatment, insurance administrative expenses, legal costs, and employer workplace costs. Indirect costs are productivity costs in the workplace due to temporary and permanent disability and decreases in production in the home resulting from disabilities. Non-injury costs are property damage and travel delay.

The injury and crash costs calculated using the human capital method do not include decreases in emotional well-being unless they result in medical treatment, nor do they include values for pain and suffering or permanent losses in functional capacity unless they result in permanent earnings losses. They also do not purport to measure decreases in the enjoyment of life. Due to those omissions, injury and crash cost totals calculated using the human capital methodology are not comprehensive. Therefore these costs should not be used in direct comparisons with the costs of reducing injuries and crashes to produce benefit-cost ratios. However, these costs can legitimately be used in the following purposes:

> for calculating the economic cost savings from reducing a given number of injuries or crashes;
>
> for demonstrating the economic magnitude of the crash problem; or
>
> for evaluating the impact of injury on a specific sub-sector of the economy such as consumption of medical resources or employer costs." (Blincoe, 1994)

The NHTSA study also made allowance for unreported crashes (mainly in the property damage only and slight injury categories) which it estimated at 42 per cent of all crashes.

An IBM compatible software program "CrashCost" was developed by NHTSA to derive total cost estimates using the "human capital" method (NHTSA June 1994). This utilises the national unit costs, and applies them to the numbers of crashes of varying severity, with adjustments for unreported crashes, for regional cost differences and for inflation, to estimate the total crash costs for a state or local jurisdiction.

The NHTSA cost categories and some of the findings are summarised in Table 8. These costs focus on the economic impact of crashes and do not represent the intangible consequences.

Table 8. The economic cost of motor vehicle crashes in the USA, 1994				
COMPONENT	TOTAL COST, ALL CRASHES		UNIT COST[3], FATAL CRASHES	
	Million US$	%	US$	%
Medical (hospital, visits, therapy prescriptions)	17026	113	12089	15
Premature funeral	138	1	3389	4
Emergency Services (ambulance, care, police, fire)	1724	12	1055	1
Vocational rehabilitation (job retraining due to disability)	156	1	0	0
Market productivity (lost wages over remaining life)	42403	282	576266	693
Household productivity (lost productive household activity at hire-in price)	12345	82	132630	159
Insurance administration (processing claims)	10456	70	28646	34
Workplace costs (work disruption)	3844	26	7489	9
Legal costs (legal fees and court costs from civil litigation)	5857	39	60766	73
Travel delay (to persons not involved but delayed)	4401	29	453	1
Property damage (vehicles, cargo and roadways damaged)	52119	346	9138	11
TOTAL	150469	100	831921	100

Source: Blincoe, 1994

The NHTSA analysis was not limited to the unit and total costs of all crashes, but also provided estimates for particular types of crashes, such as those involving alcohol intoxication or excess speed.

[3] These unit costs are on a per-person basis for the indicated injury level. Property damage costs are on a per-damaged vehicle basis

The NHTSA study also broke down the costs by source of payment, separating public sector and private sector sources.

Utilising the same methodology in successive years enables NHTSA to detect and interpret trends in costs, and to relate them to crash countermeasures.

The above costs from the NHTSA report "are the economic costs that result from goods and services that must be purchased or productivity that is lost as a result of motor vehicle crashes. They do not represent the more intangible consequences of these events to individuals and families such as pain, suffering and loss of life. Measurement of the dollar value of those consequences has been undertaken through numerous studies. These studies have estimated values based on wages for risky occupations and purchases of products for improvements in safety among other measurement techniques. These "willingness-to-pay" costs can be an order of magnitude higher than the economic costs of injuries. Currently, most authors seem to agree that the value of fatal risk reduction lies in the range of US$ 2 to US$ 5 million per life saved. An estimate of 'comprehensive costs' which combines both economic costs and values for 'intangible' consequences[4] was made based on a comprehensive analysis previously undertaken by Miller (1991)". (Blincoe, 1994). An example of these estimates, updated to 1994 values, are shown in Table 9, and depict cost as a function of severity of injury as expressed by the abbreviated injury scale (AIS).

[4] Blincoe distinguishes between the economic costs (referring to these as costs) and the valuation for lost quality of life (referring to these as values).

Table 9. Comprehensive fatality and injury costs	
INJURY SEVERITY	COST[5] IN US$ 1994
AIS 1	10 840
AIS 2	133 700
AIS 3	472 290
AIS 4	1 193 860
AIS 5	2 509 310
AIS 6 - Fatal	2 854 500

Source: Blincoe, 1994

3.3.2 Federal Highway Administration

In 1982 the Federal Highway Administration (FHWA) of the US Department of Transportation funded a contract to research alternative approaches to accident cost concepts, with the purpose of establishing fatal, injury, and property damage costs for use in highway improvement economic analyses which reflect the amount individuals are willing to pay to reduce the number and severity of accidents. This was followed by a review of accident costs, in which the comprehensive costs that people are willing to pay to avoid pain and lost quality of life for use in benefit-cost analyses were estimated, distinguishing between urban and rural areas (FHWA, 1991 and Miller, 1991). These costs were subsequently updated and issued by FHWA as a technical advisory (FHWA, 1994), and for illustration the breakdown of costs by abbreviated injury scale (AIS) is shown in Table 10.

The source data for both the NHTSA costs and values described in the previous section, and those of the FHWA described in this section, were provided by Miller (1991).

The FHWA "comprehensive cost" figures are made up of 11 components: property damage, lost earnings, lost household production, medical costs, emergency services, travel delay, vocational rehabilitation, workplace costs, administrative, legal, and pain and lost quality of life. FHWA also provides another measure of accident cost, namely "human capital cost", which includes all the "comprehensive cost" components except pain and lost quality of life.

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[5] Includes the economic cost components from Table 8 and a valuation for reduced quality of life.

Table 10. Comprehensive crash costs by abbreviated injury scale		
SEVERITY	DESCRIPTOR	COST[6] PER INJURY US$ 1994
AIS 1	Minor	5 000
AIS 2	Moderate	40 000
AIS 3	Serious	150 000
AIS 4	Severe	490 000
AIS 5	Critical	1 980 000
AIS 6	Fatal	2 600 000

Source: FHWA, 1994

FHWA equates "willingness-to-pay" cost to "comprehensive cost". This introduces confusion, as "willingness-to-pay" in Hills' approach is fundamentally different from the 11 cost components included in FHWA's "comprehensive cost".

Blincoe (1999) attempted to clarify this. "NHTSA's and FHWA's comprehensive costs include economic costs and a valuation for lost quality of life. This valuation is obtained using "willingness-to-pay" (WTP) studies that measure the implicit valuation people put on reducing risk through their everyday economic decisions. The US Department of Transportation adopted the results of a study by Miller of the National Public Services Research Institute which examined about 50 of these WTP studies, discarded the weakest ones, adjusted the others to a common basis, and then averaged the results."

USDoT's policy is that "If you are going to conduct a cost/benefit analysis in which you hope to capture all of the societal impacts of a countermeasure within the resulting ratio, you should use a comprehensive cost measure. However, if you want to measure the economic impact of traffic crashes or safety countermeasures, you should use an economic cost measure. If you are also interested in showing the lost quality of life that occurs due to traffic crashes, it should be separated from the real economic cost portion" (Blincoe, 1999).

---

[6] There is a difference between the NHTSA figures in Table 9 and the FHWA figures in Table 10. Blincoe (1999) comments "The reason the NHTSA comprehensive value is different from the FHWA value is basically that they were based on different versions of Miller's work and used different inflation adjusters. Also, although FHWA characterize their values as representing 1994, the text in the Advisory indicates that the figures were adjusted to a 1993 level."

3.3.3 Australian Road Research Board

In a series of three papers, Andreassen (1992) discussed methodologies used for determining accident costs for use in cost-benefit analyses. He distinguished between different types of accident cost estimates - for example estimates of the total cost to the community of all accidents, versus the costs of specific types of accidents used to assess the cost-benefit of safety countermeasures - and cautioned that applying the former to the latter could lead to erroneous conclusions. Differing types of accident have different outcomes in terms of the number and severity of casualties and the number of vehicles involved and the severity of their damage. For example, head-on accidents result in more severe casualties than do parking manoeuvre accidents. He described an ARRB project "Accident Costs for Project Planning and Evaluation" designed to permit explicit costing of accident types[7] (as opposed to accident severities[8]), with the following outputs:

- standardised "per person" casualty class costs for each of five casualty classes (including lost productivity, medical costs, hospital costs, ambulance, time lost at the scene, and pain and suffering);
- the casualty class outcomes for a range of 19 accident type groups
- the "per accident" costs for vehicle damage repairs for a range of accident type groups
- the standardised "per accident" costs for a range of accident type groups.

The accident types considered in the ARRB study are listed in Table 11.

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7 Accident type is defined by Andreassen as the classification of an accident according to the movements of the road users prior to the impact

8 Accident severity is defined by Andreassen as the highest casualty class recorded for the persons involved in the accident

Table 11. Accident type categories used in the ARRB Accident Costs Study	
ACCIDENT GROUP	ACCIDENT TYPE
One-vehicle types	Pedestrian crossing carriageway Permanent obstruction Hit animal Off carriageway, on straight Off carriageway, on straight, hit object Out of control on straight Off carriageway, on curve Off carriageway, on curve, hit object Out of control, on curve
Two-vehicle types	Intersection, from adjacent approaches Head-on Opposing vehicles, turning Rear-end Lane change Parallel lanes, turning U-turn Vehicle leaving driveway Overtaking, same direction Hit parked vehicle
Vehicle-Train	Hit railway train

Source: Andreassen, 1992

The importance of distinguishing between the types of accident was illustrated by the wide range of costs between the 19 road vehicle accident types in rural and urban areas - between A$ 17 000 (hit animal) and A$ 154 000 (head-on collision). In an example in which he applied accident costs to the assessment of the installation of traffic signals, he found wide differences in benefit cost ratios determined using accident cost data from the usual Accident Severity Techniques and those from the Accident Type Method he proposed. He provided a guide to the use of accident cost data in project evaluation and planning.

A more recent ARRB report (Mabbott and Swadling, 1998) pursues the use of accident costs for countermeasure evaluation. Only the abstract is available. "Millions of dollars are spent on road safety programs in Australia each year. Up-to-date accident cost data are an essential ingredient in developing programs which produce maximum benefits. The aims of this study are to briefly outline the different approaches available for estimating accident costs; to describe the results of a survey of Australian organisations likely to be using accident cost data; to identify some of the key issues and to suggest a process for ensuring up-to-date data are available. There are two major problems inherent in the use of accident costs in Australia. These are the use of different methodologies and data sources, and

problems associated with regularly updating estimated accident cost figures."

3.3.4 The external costs of road accidents

An international group of writers (Maddison et al, 1996) explored the external costs of road accidents and summarised the work of others. They focus on the value of life and limb.

The Value of a Statistical Life (VOSL) is defined as the marginal willingness to pay to avoid the risk of a fatal accident averaged over a large number of people. The willingness to pay differs from a valuation based on the present value of future income less future consumption, the value of non-marketed services such as those of a housewife, direct consequential costs such as medical bills (but excluding other direct financial costs), and a more or less arbitrary element for pain, grief and suffering. The average VOSL derived from studies done in the UK is similar to that derived from studies done in the USA. Studies in the OECD countries gave values close to UK£ 2 million, higher than the value found in the UK and the values adopted by most countries for fatalities (Table 12). The values based on willingness to pay are considerably higher than those based on gross or net earnings. There are also discernible differences which might relate to differences in GDP per capita between the countries. Another possible reason for the differences might relate to differences in social conscience between the countries. These will be discussed later.

Maddison et al expressed concern that failure to value statistical lives properly could result in a drastic misallocation of resources.

Table 12. Approved value for accidents in several European countries			
COUNTRY	YEAR	VALUE UK£, (1993 PRICES)	METHOD
Belgium	1983	323 000	Value of gross earnings
Germany	1988	673 800	Value of gross earnings
Finland	1989	1 708 000	Willingness to pay
France	1985	274 200	Value of lost years
Great Britain	1988	948 100	Willingness to pay
Luxembourg	1978	351 500	Value of net earnings
Netherlands	1983	90 600	Value of net earnings
Norway	1988	362 800	Value of gross earnings
Austria	1983	584 300	Value of gross earnings
Portugal	1976	13 100	Value of gross earnings
Sweden	1990	2 102 300	Willingness to pay
Switzerland	1988	1 781 100	Willingness to pay
Spain	1984	153 800	National product

Source: Maddison et al, 1996

3.3.5 Transport Research Laboratory - Developing Countries

The Transport Research Laboratory (TRL) in the UK is also active in developing countries, and has provided guidelines for costing road accidents in such countries (TRL 1995). Since a large proportion of South African traffic collisions occur in an environment which is essentially a developing one, these guidelines might be relevant to South Africa.

TRL considers the six different approaches to accident costing described earlier (section 3.2.3), and focuses on the "gross output" and "willingness-to-pay" methods. It considers the "willingness-to-pay" method as the most appropriate for cost-benefit analyses, but notes the various difficulties in obtaining reliable empirical estimates. These would be heightened in developing countries, where it would be more difficult to value changes in risk because of the difficulty of respondents in providing a monetary value where markets do not necessarily involve money exchange, such as in the informal sector of the economy. TRL concludes that "it is unlikely that reliable willingness-to-pay based costs will be available for use in developing countries for some time. It is therefore recommended that the gross output

approach is used to cost road accidents in developing countries. However, in order to try to capture some of the more 'humane' considerations reflected in the willingness-to-pay approach, gross output values should be augmented by a further allowance for 'pain, grief and suffering' of those involved in road accidents" (TRL 1995).

The TRL then describes how to use the gross output method in practice, and provides helpful guidelines on some of the problem areas commonly encountered, in valuing loss of output, cost of medical treatment, cost of damage to vehicles and other property, administrative costs, and subjective costs.

TRL undertook a case study, demonstrating the application of the gross output method in Cyprus. For illustrative purposes, the results of this case study are summarised in Table 13.

Table 13. Unit cost of a fatal accident in Cyprus, 1984

COST COMPONENT	COST UK£
RESOURCE COSTS (Damage to vehicle, lost output, medical, police and administration)	101 800
NON-RESOURCE COSTS (Pain, grief and suffering)	38 600
TOTAL	140 400

Source: TRL 1995

3.4 Integrated cost-benefit packages

Cost-benefit analyses of road investment or upgrading projects generally include the reduced cost of collisions as one of the benefits. Such analyses are generally undertaken using integrated cost-benefit computer packages. These packages, utilising conventional economic analysis techniques, make the analyses easier for the user by including databases, algorithms or models which estimate the road and user costs corresponding to the design of a particular alternative. Some of the more widely used packages are the following:

World Bank

"The Highway Design and Maintenance Standards Model (HDM-III) was developed by the World Bank's Transportation Department to meet the needs of highway authorities, particularly in developing countries, for evaluating policies, standards, and programs of road construction and

maintenance. The latest version is the 1995 HDM-III System, issued in 1995.

The model simulates total life cycle conditions and costs for one road, a group of roads with similar characteristics, or an entire network of paved or unpaved roads, for a series of road agency construction or maintenance strategies, and provides the economic decision criteria for evaluating the strategies being analysed. The primary cost set for the life cycle analysis includes the costs of road construction and maintenance and vehicle operating costs, to which travel time costs can be added. The costs of construction-related traffic delays, accidents and environmental pollution can be entered in the model exogenously, based on separate estimates.

The model does not endogenously predict road accidents or their costs, nor environmental impacts such as air and noise pollution, nor traffic delay costs during road construction or maintenance. Facility is provided, however, to incorporate accident costs, delays, and environmental impacts where exogenous estimates are available. The user confronted with any of the above conditions should recognize that they are outside the empirical base of the present model and should make appropriate provisions or adaptations in the analysis." (World Bank, 1995).

"The Highway Design and Maintenance Standards Model (HDM-4) is to be released in April 1999. This is an international effort to develop improved road investment appraisal methods. It will build upon the widely-used Highway Design and Maintenance Standards model HDM-III, extending and developing it with:

Technical relationships updated and calibrated to the best current knowledge.

Additional technical capabilities for dealing with traffic congestion, non-motorized vehicles, concrete pavements, drainage, environmental and safety effects.

Improved system design, software and applications framework for use at various levels of planning, budgeting, appraisal and management of roads.

The study will considerably broaden the scope of such models beyond traditional project appraisal, providing a powerful system for the analysis of road management and investment alternatives." (World Bank, 1999).

National Transport Commission and South African Roads Board

During the 1970s the National Transport Commission (NTC) introduced a requirement that all road proposals submitted to it must be justified by a cost-benefit analysis. During the 1980s the Central Economic Advisory Service developed and issued a manual and requirements for cost benefit analyses in South Africa (CEAS 1989). The Department of Transport, together with the Committee of State Road Authorities, set up a Committee for Road Project Evaluation, which guided the development and implementation of a methodology for cost-benefit assessment of road investment, upgrading, and rehabilitation in accordance with the CEAS manual. An associated computer program, CB-Roads (SARB 1994) was later developed to undertake cost-benefit analyses of rural road projects and small road networks. As this program carried out the routine and previously-structured calculations, the analyst was relieved of the tedium of gathering and inputting common data, and was required only to input project-specific information. Use of this software package and standard data tables had the additional advantage of ensuring that all road assessments were undertaken on a similar basis and were comparable with one another. Analysts deviating from the standard procedures and data sets, for example in the case of a project requiring a more sophisticated approach, were required to motivate such deviation.

A component of CB-Roads is its Standard Data Tables. These include a database of road and transport costs, including collision costs, which are updated regularly. The most recent update is in a format which is compatible with both CB-Roads and HDM-IV (Naude 1999). An associated but wider database of transport costs, including collision costs, is the software package CostData which is currently being updated.

When the responsibility for national roads was transferred from the NTC to the South African Roads Board, the SARB adopted CB-Roads. With the decline in the construction of new roads in South Africa, the program came to be used mainly for the justification of road improvement and rehabilitation projects. In 1998 the SANRA and SARB decided to adopt the HDM-III package in place of CB-Roads.

South African Provincial and Local Authorities

Provincial and local authorities and their consultants generally use CB-Roads for economic evaluations.

Southern African Development Community

Studies undertaken for SADC or SATCC generally utilise the World Bank's HDM-III package.

3.5 International comparison of collision costs

It is of interest to compare the collision cost estimates made for different countries, as a basis for assessing the reasonableness of South African estimates.

The values in Table 14 are for fatalities, which is only one of many categories required for economic analyses, but which should best illustrate the differences between countries. The values are converted to 1996 Rand using GNP per capita growth rates for the different countries and 1996 currency exchange rates. These figures are not directly comparable, because exchange rates do not reflect the differences in buying power between currencies. The detailed comparison is left to the interpretation of the reader.

Some of these values are based on a "gross output" methodology, others on a "willingness-to-pay" methodology. There seem to be differences between the application of these methodologies and in the use of these terms between the different studies, which ought to be clarified.

There are clearly large differences (see the cells with the heavy border), the South African values being far below those in developed countries. The South African values are also far below those for a developing country, Cyprus, as was shown in Table 13.

Some but not all of this difference might be explained by the differences in GNP per capita, and the differences between the output and the willingness-to-pay approaches. These and other reasons for the differences ought to be investigated in depth.

Table 14. A comparison of fatality cost estimates between South Africa and three developed countries

COUNTRY	GNP per capita[9]		INJURY AND COLLISION COST ESTIMATES					BASIS OF ESTIMATE	SOURCE
	US$ 1996 (1000s)	Rand 1996 (1000s)	YEAR	UNIT COST OF A FATAL INJURY	UNIT COST OF A FATAL COLLISION				
				Local currency (millions)	Local currency (millions)	Local currency 1996 (millions)	Rand 1996 (millions)		
South Africa	329	138	1991		R 0,184	R 0,24	R 0,24	Gross output + PGS[10]	de Haan (1992)
			1993		R 0,227	R 0,29	R 0,29	Output based on GDP per capita	CB-Roads (1994)
Australia	1963	825	1989		A$ 0,56	A$ 0,77	R 2,5	Output + PGS	NAASRA (1989)
USA	2786	1170	1994	US$ 0,83				Output	NHTSA (Blincoe 1994)
			1994		US$ 2,6	US$ 2,8	R 11,8	WTP[11]	NHTSA & FHWA (1994)
United King-dom	1971	828	1995	UK£ 0,88	UK£ 0,98	UK£ 1,0	R 6,7	WTP	DETR
			1996					WTP	Hopkin (1996)

[9] Source: World Bank Reports

[10] Pain, grief, suffering, and loss of amenities of life

[11] Willingness-to-pay

4. POSSIBLE METHODOLOGIES FOR ESTIMATING COLLISION COSTS

From the preceding sections it can be seen that collision costs cannot be determined exactly and have to be estimated. As a basis for updating the South African estimates, this section considers alternative methodologies for making such estimates and the compromises that have to be adopted because of the lack of data.

4.1 Scope

The primary use of the estimates which will be provided by this study is in the cost/benefit analysis of road investment alternatives. Therefore the study should cover the most significant collision cost components, for all types of collisions, nationwide, the greatest emphasis being on those cost components making up the greatest proportion of the total cost. It should not focus on specific cost components or on specific types of collisions.

The basic output should be collision costs per severity of collision. Ideally, the methodology and data sources selected should also permit a breakdown of the cost estimates into the categories shown in Table 3. The feasibility of this will be discussed later.

It will be recommended that a separate study be undertaken as soon as the NaTIS/TRAFMAN collision register is fully operational, to permit a breakdown by type of collision as was done by Andreassen (1992).

4.2 Methodologies

The costs incurred by road traffic collisions include a variety of uncontroversial resource costs relating to property damage, and medical, administrative and legal expenses, and to more controversial costs related to the human elements of collisions. As discussed in section 3.1, the two main methods for the determination of the latter are the "gross output" with allowance for intangibles and the "willingness to pay approaches. For the reasons expressed by de Haan (1992), the "gross output" approach, together with an allowance for the intangible elements of pain, grief and suffering and the loss of amenities of life, is currently considered to be the most appropriate for application in South Africa.

It is proposed that the loss of future output of those killed in road collisions be estimated using two methods:

based on likely future earnings - as used by de Haan (1992)
based on GDP per capita - as used in CB-Roads (SARB 1994)

and the two results compared before a final methodology is selected. As for the other cost components, it is proposed that the methodologies used by de Haan be repeated. Finer points of the methodologies will have to be adapted to suit the data and survey methods, as discussed in subsection 4.3.

COLLISION COST COMPONENTS PROPOSED

Loss of output
Hospital, medical and funeral costs
Pain, suffering, and loss of amenities of life
Vehicle damage
Damage to goods carried
Damage to fixed property
Legal costs
Insurance administrative costs
Towing costs
Policing and promotion costs

4.3 Data

In quantifying the above categories of costs, a variety of data is required. However, some of these data are not readily available. In this section the data required and sources of such data will be identified, and alternatives and surrogates for unavailable data discussed.

Since no single source will provide all the data required, it will be necessary to derive data from a variety of sources. Generally it will not be possible to link the data from different sources. It is theoretically possible, if collisions are correctly recorded, to link the SAPS collision report, the short-term insurance claim, and the RAF claim for an individual collision - although this is unlikely to be feasible in practice and, moreover, doing so might compromise the randomness of sampling (see later). This will, it is hoped, become more feasible when the NaTIS collision register now being implemented becomes fully operational and populated.

4.3.1 Road collision occurrence data

The collision data required as a basis for estimating collision costs are shown in the following box.

Road Collision Data Required

Collisions (fatal, serious, slight, damage only) by status (driver, passenger, pedestrian)
Casualties (fatal, serious, slight) by status (driver, passenger, pedestrian)
Vehicles involved (car, LDV, minibus, HCV rigid, articulated, bus, motorcycle, pedal cycle, animal-drawn)
Fatalities by age group and status (drivers, passengers, pedestrians)
Seriously injured by age group and status (drivers, passengers, pedestrians)
Slightly injured by age group and status (drivers, passengers, pedestrians)
Casualties per collision by severity and status (drivers, passengers, pedestrians)
Vehicles per collision by severity and status (drivers, passengers, pedestrians)
Actions of vehicles prior to collision

The primary source of road collision data in South Africa has been the Central Statistical Service (CSS), recently renamed Statistics South Africa (SSA). The most recent data on road traffic collisions published by CSS is for the calendar year 1997 (CSS 1998). It is expected that the data for 1998 will have been processed by May 1999 and be published by SSA by January 2000. As from March 1999 collision data recorded in the new SAP352 booklet will be captured by the various law enforcement agencies in the TRAFMAN system and then incorporated into the NaTIS collision register.

CSS data for South Africa up to 1995 were generally for the then area of the Republic of South Africa only and excluded the areas of Transkei, Bophuthatswana, Venda and Ciskei. Data on the former TBVC states are included from January 1996.

The CSS classification and definitions of the severities of injuries and collisions are shown in the following two text boxes (CSS 1998):

Classification and definitions of the severity of injuries sustained in road collisions	
Fatal injury	Injuries which cause death, either immediately or subsequently, but not later than six days after the collision
Serious injury	Fractures, crushings, concussion, internal injuries, severe cuts and lacerations, severe shock requiring medical treatment, and any other injuries which necessitate hospitalisation or confinement to bed
Slight injury	Cuts and bruises, sprains and light shock

Classification and definitions of the severity of a road collision	
Fatal collision	Collisions involving the death of persons, either immediately or subsequently as a direct result of the collision. Deaths up to six days after the date of collision are included.
Major collision	Collisions involving serious injuries to persons
Minor collision	Collisions involving slight injuries to persons.
Damage only collision	Vehicle damaged, but no injury of any kind to persons

4.3.2 Vehicle data

Vehicle Data Required
Vehicles registered in SA (car, LDV, minibus, HCV rigid, articulated, bus, motorcycle)

The CSS ceased to record data on vehicles registered in June 1992. Since that time no reported data have been available on vehicles registered, although CSIR has made estimates. The National Traffic Information System (NaTIS) contains live (but no historic) data on vehicles registered and drivers licensed. As from March 1999 NaTIS will include a collision register, as described above. NaTIS will also in future include an offence register based on convictions for road traffic offences, which will form the basis of a driver points demerit system. Extracts from and analyses of NaTIS databases can only be undertaken by Messrs Fischer and Associates. Data on current vehicle registrations can be requested from NaTIS by the National Department of Transport.

4.3.3 Data relating to pain, grief, suffering, and loss of amenities of life

In view of the recommendation not to undertake a willingness-to-pay study, the only component relating

to intangible human values will be an estimate of the values attached to pain, grief, suffering, and loss of amenities of life.

Data required relating to pain, grief, suffering, and loss of amenities of life
Compensation awarded - by injury severity

The only plausible source of data to assess (even though only partially) this intangible is the compensation awarded in RAF claims or by the courts. The latter awards are made on subjective humanitarian grounds, and possibly reflect best the value that society places on such intangibles.

4.3.4 Data relating to loss of output

The other human component is the loss of economic output of persons killed or injured in collisions. As opposed to the previous category, this is a tangible cost.

Output Data Required
Unemployment rates Income of employed persons by age group Income of informal sector by age group Life expectancy per age group GDP per capita
Sick leave taken by persons injured

The required data are available in the annual reports of SSA, with the exception of data on the informal sector, which is unreported.

Actuarial life expectancies are readily available, but possibly require reconsideration in view of the rapid spread of HIV and AIDS in South Africa and the potential of earlier deaths of a significant proportion of the population.

Use of this methodology requires a number of assumptions regarding:

economically active ages,

economically active persons,

the output of persons in the informal sector who are economically active but for whom no data are available,

the output of persons providing unpaid services such as homemakers and voluntary social workers,

duration of productive time lost by persons who are injured or disabled, and

whether persons injured or killed in road collisions are representative of or differ from the entire population. The latter will become a larger area of uncertainty as a result of the proposal, in accordance with the RSA Constitution, not to distinguish in the analysis on the basis of race or gender.

4.3.5 Ambulance, hospital, medical and funeral cost data

Data required relating to ambulance, hospital, medical and funeral costs

Collision-scene emergency medical service (EMS) or paramedic treatment costs
Ambulance (road or helicopter) costs
Hospital costs - by collision severity and by status (driver, passenger, pedestrian)
Immediate and estimated future medical expenses - by collision severity and by status (driver, passenger, pedestrian)
Funeral costs

The Road Accident Fund (RAF), previously Multilateral Motor Vehicle Accidents Fund (MMF), and previous to that the Motor Vehicle Accident Fund (MVA) "Third Party" provides compensation to victims of road collisions for medical and hospital expenses, scarring, pain, suffering and loss of amenities of life, funeral, legal and medico-legal costs and loss of income.

4.3.6 Vehicle damage cost data

Vehicle Damage Cost Data Required

Costs of damage to vehicles - by vehicle involved (car, LDV, minibus, HCV rigid, articulated, bus, motorcycle) and by collision severity

Possible sources of data on the cost of damage to vehicles in road traffic collisions include:

Short-term insurers

Owners of fleets of vehicles, such as the Government Garage, government departments, private sector companies, car hire firms

Associations of transport operators, such as RFA, SABOA, taxi associations

Some of the limitations or problems in using such sources for the present purpose are:

Short-term insurers: Vehicles owned by private sector companies are generally insured comprehensively by a short-term insurer. Vehicles owned by individuals which have been purchased on a hire-purchase scheme and vehicles on long-term leases are generally required by the financing institution to carry comprehensive insurance. Some fully privately owned vehicles carry comprehensive insurance. Such comprehensive insurance includes insurance against damage to vehicles arising from collisions. However, other, generally lower value older vehicles, carry "balance of third party" insurance which does not cover damage to the vehicle itself but protects the owner against claims for damage to other vehicles involved in a collision. Finally, a large proportion of vehicles carry no insurance whatsoever. The latter are mainly vehicles owned by members of lower income groups and are generally of lower value and older vehicles, but some owners of higher value and newer vehicles also do not insure and carry their own risks.

Thus only a proportion of vehicles carry comprehensive insurance, and inferring generalisations for all vehicles based on the damage claims of a sample of the proportion insured introduces the likelihood of bias if the insured vehicles are not representative of the entire cross-section of vehicles involved in collisions. Moreover, since policies generally include penalties for claims against them, policy-holders will generally not claim for minor-damage collisions, and thus the claim records of insurance companies will under-reflect the costs of damage-only collisions.

Nevertheless, extracting collision cost data from the claims lodged with the relatively few short-term insurance companies is feasible.

Vehicle fleets: Owners of large vehicle fleets usually, but not always, maintain records of all costs associated with individual vehicles, including collision costs. This source is, however, not an attractive one, because of the large number of companies that would have to be approached, and because the data it would provide is included in that obtainable from short-term insurers.

Associations of freight transport operators: The major body in this category is the Road Freight Association (RFA), which includes almost all first-tier, a large proportion of second-tier,

but few third-tier for-reward and own-account road freight operators (see MSA 1998). The RFA has some data on the operating costs of its members and would be able to request specific data, such as collision costs, from its members.

The RFA is a feasible source of representative data on the costs of collisions involving vehicles of first- and second-tier operators. It will not however be a source of data relating to the generally small and informal third-tier operators.

Associations of bus transport operators: Most of the larger private sector, municipal, and parastatal bus operators in South Africa are members of the Southern African Bus Operators Association (SABOA). SABOA has data on the operating costs of its members and would be able to request specific data, such as collision costs, from its members.

This is a feasible source of representative data on the costs of collisions involving buses, but again, will not provide data relating to the many small informal-sector bus operators.

Mini-bus taxi associations: There are many minibus-taxi associations in South Africa, which in terms of legislation are required to register with the provincial Taxi Registrars. They maintain records of their members, who are mostly small informal-sector one-vehicle operators, but have no records of the operating costs of their members, who generally do not maintain formal records.

4.3.7 Other property damage cost data

Other Damage Cost Data Required

Costs of damage to goods in transit - by vehicle type (car, LDV, minibus, HCV rigid, articulated, bus, motorcycle) and by collision severity

Previous studies did not estimate the cost of damage to goods being carried by vehicles in collisions, because of the lack of relevant data. A potential source of data pertaining to goods vehicles is the RFA.

For the same reason, previous studies did not estimate the cost of damage to fixed property - such as traffic lights, street lighting, road signs, bridge structures and railings, guardrails and other roadside furniture, or to the road surface damaged by spillages or fire. The roads departments at the three levels of governments do however budget for such replacements under their maintenance budgets. It should be possible to estimate the cost of damage to fixed property from the percentage of the road authority

budgets reserved for this item.

4.3.8 Legal cost data

Legal cost data required

Legal costs of claims against short-term insurers - by victim status (driver, passenger, pedestrian) and by collision severity
Legal costs of claims against RAF - by victim status (driver, passenger, pedestrian) and by collision severity
Medico-legal costs of investigations required by RAF - by victim status (driver, passenger, pedestrian) and by collision severity

These are the legal costs paid to the claimant in claims against insurers. These include legal costs paid out by the short-term insurers in respect of motor vehicle claims, the RAF's contribution to the legal costs of the claimant and the RAF's expenses for the medico-legal costs of the investigations it requests. Data are available from the short term insurers and the RAF.

4.3.9 Miscellaneous cost data

Miscellaneous cost data required

Towing costs - by vehicle type (car, LDV, minibus, HCV rigid, articulated, bus, motorcycle) and by collision severity

Clean-up costs of spillages of hazardous chemicals

Miscellaneous collision-related variable costs may be identified.

One of these is loss of time (other than work time lost as a result of injuries dealt with previously) - such as reporting to the police, visits to insurance companies, court appearances, hospital visits, attendance of funerals. As hard data are available, the estimates must be based on assumptions.

Depending on the type and severity of collision, other on-site services may be required, such as:

Towing costs from the scene of collision to the repair shop or scrapyard. Data are available from the claims against short-term insurers.

Costs of clean-up of the collision scene. Removal of wreckage (other than the vehicles, which are removed by towing operators) is undertaken by the traffic department to the extent

necessary to reopen the road to traffic. The costs of repairs to the road or roadside furniture have been discussed previously, and are provided for in the maintenance budgets of road authorities.

Costs of other emergency services. The costs of emergency medical services have been discussed previously. The costs of fire-fighting services, or of hazardous material specialist services where there has been a spillage or potential spillage of flammable, explosive, poisonous, corrosive, or environmentally polluting cargo, are recoverable from the operator. Data might be available from members of the RFA and from the hazardous material specialist service providers.

4.3.10 Insurance administrative cost data

Insurance administrative cost data required
Costs of insurance administration

Insurance administrative costs consist of management and administrative expenses and commissions. The Registrar of Insurance totals such costs as reported by short-term motor insurers. Since only a total sum is available, this has to be distributed between the various categories, using reasonable assumptions.

4.3.11 Policing cost data

Data required relating to costs of policing
Costs of road traffic administration, control, law enforcement, collision investigation, and safety promotion

Various departments or agencies of the three levels of government undertake activities relating to road traffic administration, control, law enforcement, collision investigation, or safety promotion. These include:

SAPS traffic enforcement and collision investigation
NDoT Directorate Traffic Management and Traffic Safety Communication
Provincial Directorates of Traffic Control and Traffic Safety
RTMC (if it is established.)

Local authority traffic policing and vehicle licensing departments

As their activities do not relate solely to traffic collisions, only selected portions of their budgets will be relevant and should be included in the fixed costs.

4.3.12 Representativeness of the cost data obtained from these sources and its effect on overall accuracy of estimate

As a guide to design of the data gathering for a future study, it is helpful to consider the relative proportions of the costs of previous studies by cost component. Figures 4 and 5 show these proportions for the most recent comprehensive study, that of de Haan (1992). Vehicle damage was the largest component of the total cost of collisions, followed by loss of output. The latter was the largest component in the case of fatal collisions.

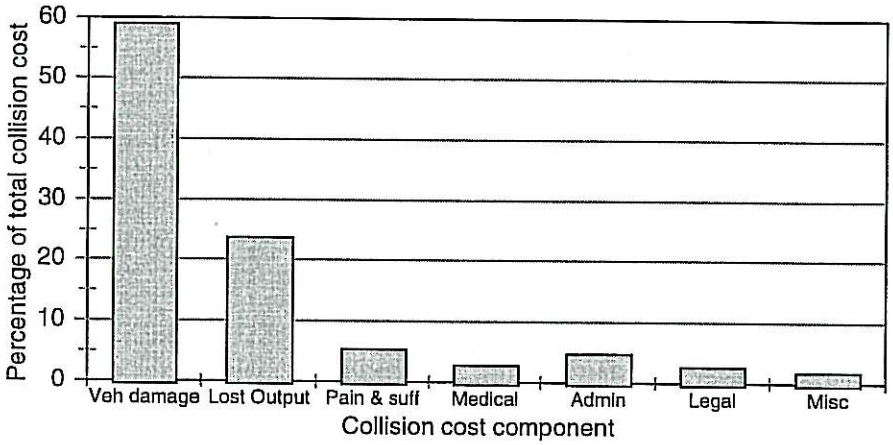

Figure 4. Percentages of total cost of collisions made up by various components (de Haan 1992)

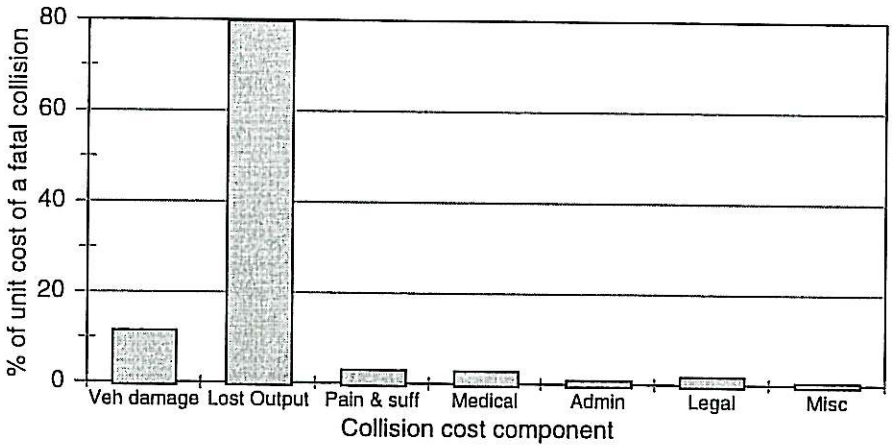

Figure 5. Percentages of unit cost of a fatal collision made up by various components (de Haan 1992)

Errors in the larger cost components will have the greatest effect on the accuracy of the overall estimate of collision costs and warrant special consideration.

The methodology proposed for estimates of the costs of vehicle damage involves a survey of claims made against short-term insurers. De Haan's 1992 study included a survey of 2464 claims at six short-term motor vehicle insurers.

It is proposed that the medical expense and pain and suffering category estimates be based primarily on a survey of claims against the RAF. In this case de Haan's 1992 study included a survey of 3656 claims at four insurers acting as agents for the then MMF.

In both cases the sample sizes were determined statistically to provide reliable estimates of these cost components.

It is important that future surveys be correctly planned statistically in terms of stratification, sampling, and sample sizes, in order to ensure that the surveys are statistically representative of the population of collisions.

This will require segmentation of the population of collisions into segments which might be expected to have significantly different unit costs of collisions or of collision cost components. This might be the same as the categories identified in Table 3, but is likely to include segmentation by:

urban/rural
vehicle type
occupant/pedestrian
collision severity

It is proposed that loss of output be estimated using two different approaches: In this case the cause of inaccuracy is not so much the data, which is reported by the CSS, but the use thereof and the far-reaching assumptions that have to be made, relating to the treatment of the output of the unemployed, persons employed in the informal sector, and persons rendering important but unpaid services.

Some of the other cost categories too are prone to errors as a result of the use of surrogate data where the required data are not available, and because of the assumptions made. It is important that the analysis identify such probable errors, for each of the cost categories, and identify the possible direction of any bias, at least qualitatively.

5. SPECIFIC PROPOSALS FOR UPDATING SOUTH AFRICAN COLLISION COST ESTIMATES

It is proposed that the above methodology be applied and reported in Phase 2 of this project.

5.1 Data acquisition

It is proposed that the data requirements described in the previous section be met from the sources listed in Tables 15 and 16. Where relevant, these will be based on statistically representative samples.

Table 15. Summary of proposed collision data sources

COLLISION DATA	DATA SOURCE
Collisions Casualties Vehicles	CSS collision statistics for 1997 currently available SSA for 1998 available after May 1999
Vehicle movements prior to impact	SAP 352 TRAFMAN NaTIS via NDoT for Gauteng and Northern Province (planned from March 1999)
Vehicles registered	NaTIS via NDoT

Table 16. Summary of proposed cost data sources	
COST COMPONENT	**DATA SOURCE**
The value of lost output: Income profiles, unemployment rates, life expectancies, GDP/capita Time off work	CSS South African Statistics Road Accident Fund
Hospital, medical and funeral costs	Road Accident Fund
Pain, suffering, and loss of amenities of life	Road Accident Fund
Vehicle damage Freight vehicles Bus	Current short-term insurers Road Freight Association SA Bus Operators Association
Damage to goods carried	Road Freight Association
Legal costs	Short-term insurers Road Accident Fund
Insurance administrative costs	Registrar of Insurance
Towing costs	Short-term insurers
Policing and promotion costs	SAPS NDoT Provinces RTMC Sample of local authorities

5.2 Analysis

Previous studies using methodologies similar to that proposed above identified inconsistencies in the data, and made appropriate assumptions to overcome these. This may also prove to be the case when the above proposals are implemented, and the research team may be forced to make similar assumptions. These cannot be predicted at this stage.

For the sake of consistency and transparency, and to permit the influence of changes in assumptions to be assessed, it is proposed that all analyses (except the primary processing of raw data) be performed on a single spreadsheet, annotated with sources and assumptions.

It is proposed that a summary of the estimates, broken down into the categories proposed in Table 3, be uploaded onto the National Department of Transport's Internet web site, permitting easy access by interested persons. If, as proposed by the NDoT, these estimates are updated regularly, this will become a permanent resource for policy makers, planners, managers, investment decision makers and analysts.

A similar approach to that described by Blincoe (NHTSA, June 1994) could be used to apply South African national estimates to make estimates for road networks which are the responsibility of provincial or local authorities. However, this "short-cut" approach would give results less accurate than repeating the full study proposed in this report for the specific network.

6. CONCLUSION AND RECOMMENDATIONS

This document has reviewed earlier South African and international studies of the economic costs of road collisions and of the methodologies used in those studies.

It constitutes Phase 1 of an investigation for the National Department of Transport "Revision of the unit cost of road traffic collisions in South Africa as an input to economic evaluation".

It is recommended that, as Phase 2 of the project, the economic costs of road collisions in South Africa be quantified by severity of collision (fatal, major, minor, and damage-only) and by the additional categories set out in Table 3. This should be done in a manner which will permit routine updating of the estimates in future years.

It is recommended that the "gross output" methodology be adopted, rather than the "willingness-to-pay" methodology.

It is recommended that sample sizes be determined statistically to ensure reliable estimates of the cost components.

Taking into consideration the rate at which changes in the economy and in road traffic occur, it is recommended that all cost components be updated every three years. In the intervening years it is recommended that the most recent estimates be adjusted in proportion to the change in GDP per capita (for the output and value of life components) and in proportion to the consumer or production price index (for all of the other components),

This quantification will provide the data required for both macro-economic policy-making and for the cost-benefit analysis of road infrastructure investment, upgrading and rehabilitation alternatives.

For the micro-economic analysis of road infrastructure improvements and other collision countermeasures, it is critical to categorise collisions by collision type, rather than by severity. Using cost information per severity will in fact result in wrong investment decisions in some cases. Because of the incomplete reporting and data capturing of collisions at present, and because of the difficulty of matching data from three independent sources, it is at present not feasible to quantify collision costs by type of collision. This should become feasible once the NaTIS collision register has been established and populated, and it is recommended that a separate study be undertaken to develop the methodology

for such categorisation.

Regrettably little collision cost data are available for developing countries, which might be comparable to South Africa. Even so, there are large differences between developed countries in the values for fatal collisions. These differences are partly due to differences in how human life is valued (both by the analyst but also more fundamentally by the society concerned), and due to differences in GDP per capita, but possibly due to other differences as well. Because of the importance and implications of the resulting costs, it is recommended that more in-depth research be undertaken on this aspect.

Several recent studies in South Africa, outside the roads sector, have placed implicit values on human life. It is desirable that such values, if used, be the same across all sectors, in order to prevent misallocation of limited resources between sectors.

In view of the potentially far reaching implications of any significant change in the collision costs derived in Phase 2, it is recommended that a workshop of interested and affected parties be held to note the changes and to consider budget reallocations.

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Annexure A. TERMINOLOGY AND ABBREVIATIONS

A.1 Definitions

Accident	An unintended road traffic event, resulting in damage, injury or death.
Collision	Identical to the term "accident" the term "collision" was preferred and adopted by the Department of Transport in the 1980s. In this report the term "collision" is used, but in reviewing earlier or foreign reports using the terms "accidents" or "crashes", those terms are used.
Damage only collision	Vehicle damaged, but no injury of any kind to persons.
Fatal collision	Collisions involving the death of persons, either immediately or subsequently as a direct result of the collision. Deaths up to six days after the date of collision are included.
Fatal injury	Injuries which cause death, either immediately or subsequently, but not later than six days after the collision.
Major collision	Collisions involving serious injuries to persons.
Minor collision	Collisions involving slight injuries to persons.
Serious injury	Fractures, crushings, concussion, internal injuries, severe cuts and lacerations, severe shock requiring medical treatment, and any other injuries which necessitate hospitalisation or confinement to bed.
Slight injury	Cuts and bruises, sprains and light shock.

A.2 Acronyms and abbreviations

AIS	Abbreviated Injury Scale
ARRB	Australian Road Research Board
CEAS	Central Economic Advisory Service
CSS	Central Statistical Service (now Statistics South Africa)
DETR	Department of Environment, Transport and Regions, UK
FHWA	Federal Highway Administration, US Department of Transportation
GDP	Gross Domestic Product
GNP	Gross National Product
LDV	Light delivery vehicle
HCV	Heavy commercial vehicle
MMF	Multilateral Motor Vehicle Accidents Fund established under the Multilateral Motor Vehicle Accidents Fund Act, Act 93 of 1989 - provides compensation for medical and hospital expenses, pain, suffering and loss of amenities of life, funeral, legal and medico-legal costs and loss of income
MVA	Motor Vehicle Accident Fund established under the Motor Vehicle Accident Act 84 of 1986 - provides compensation for third parties involved in collisions, for medical and hospital expenses, loss of income, scarring, pain and suffering, loss of amenities of life, and legal and medico-legal costs.
NAASRA	National Association of Australian State Road Authorities (now Austroads)
NaTIS	National Traffic Information System
NDoT	National Department of Transport
NHTSA	National Highway Traffic Safety Administration, US Department of Transportation
NRSC	National Road Safety Council established under Act 9 of 1972, whose functions were taken over from September 1992 by the Directorate: Traffic Safety in the Department of Transport in accordance with the Transport General Amendment Act, Act 86 of 1992
NTC	National Transport Commission. Its roads functions were taken over by the SARB
PGS	Pain, grief and suffering
RAF	Road Accident Fund established under the Road Accident Fund Act, Act 56 of 1996 - provides compensation in accordance with this Act for loss or damage wrongfully caused by the driving of motor vehicles
RFA	Road Freight Association
RTMC	Road Traffic Management Corporation as proposed in the Draft Road Traffic Management Corporation Bill, 1998

SABOA	Southern African Bus Operators Association
SADC	Southern African Development Community
SANRA	South African National Roads Agency
SARB	South African Roads Board
SATCC	Southern Africa Transport and Communications Commission
SSA	Statistics South Africa (previously Central Statistical Service)
TRL	Transport Research Laboratory
USDoT	United States Department of Transportation
VOSL	Value of a Statistical Life
WTP	Willingness to pay